Lady beetles (Coleoptera: Coccinellidae: Coccinellini) associated with Alaskan agricultural crops

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ABSTRACT

Adult coccinellid abundance was monitored in agricultural areas of the Tanana and Matanuska-Susitna River valleys of Alaska during 2004 and 2005. Thirteen species were collected in association with Alaskan agricultural crops. Of the species collected, *Hippodamia quinquesignata quinquesignata* (Kirby), *Coccinella transversoguttata richardsoni* Brown, and *Hippodamia tredecimpunctata tibialis* (Say) were by far the most abundant species, making up 51, 18, and 12%, respectively, of the individuals collected. Two new species, *Coccinella septempunctata* L. and *Hippodamia convergens* Guerin, were recorded for the first time in Alaska.

Key Words: lady beetles, biodiversity, integrated pest management, Alaska

INTRODUCTION

There has been much interest in the expansion of agricultural production in the circumpolar region in recent years (Anonymous 1998, 2001, Whitfield 2003). Alaska has tremendous agricultural potential, with approximately eight million hectares of arable land. However, the taxonomic identity, biology, population dynamics, and distribution of insect pests and their natural enemies in the circumpolar region is lacking or poorly understood (Pantoja *et al.* 2009). There is a need for increased research to improve management and to understand the biology of insect pests in arctic and subarctic regions. The development of pest management practices for Alaska is of particular interest since it is expected that insect populations in the state may increase with climate change (Whitfield 2003).

In recent years, USDA-ARS, in cooperation with the University of Alaska, has made efforts to develop integrated pest management (IPM) programs for Alaskan agricultural crops. However, some of the fundamental knowledge necessary to develop IPM systems is lacking. In Alaska, the beneficial insect complex associated with agricultural crops is not well known. Knowledge of the taxonomic identity and biology of beneficial insects is a critical component of IPM systems (Pedigo 1999). Published information on Alaskan coccinellids has been limited to distribution records within taxonomic treatments (Belicek 1976, Gordon 1985) and faunal lists (McNamara 1991). Additional research is needed to determine the taxonomic identity, distribution, and population dynamics of agriculturally beneficial insects in Alaska.

Coccinellids are commonly associated with biological control of pest species (Obrycki and Kring 1998). Members of the tribe Coccinellini are primarily aphidophagous (approx. 75-85%) (Hodek and Honěk 1996) and are easily recognizable in agricultural systems. Lady beetles have a wide distribution and occur in high numbers in agricultural habitats. Gordon's (1985) taxonomic monograph includes distribution maps and keys that include all Alaskan species. In addition Belicek (1976) and McNamara (1991) provide additional

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records for Alaska, but no studies have been conducted to survey the coccinellids associated with Alaskan agricultural crops. The purpose of this study was to provide baseline information on the species composition of coccinellids of the tribe Coccinellini associated with agricultural crops in Alaska.

MATERIALS AND METHODS

During 2004 and 2005 adult lady beetles of the tribe Coccinellini were surveyed in and around agricultural areas in the Tanana (near Nenana, N64.70° W148.86°; near Fairbanks N64.85°, W147.85°; near Delta Junction N64.15°, W145.81°) and Matanuska (near Palmer N61.57°, W149.25°) river valleys of Alaska. Sites in Fairbanks and Nenana were bordered by mixed boreal forest. Delta Junction sites were bordered by Conservation Reserve Program (USDA-NRCS) grasslands and boreal forest. Palmer sites were located in more developed rural areas adjacent to large-scale commercial agricultural lands.

Sampling was conducted in potato (*Solanum tuberosum* L.), rhubarb (*Rheum rhabarbarum* L.), and low-input mixed vegetable plantings. Beetles were captured by a variety of methods including Japanese beetle traps, yellow adhesive cards, water pan traps, sweep netting, and hand picking.

Japanese beetle traps (JBT) (Trece Catch Can, Trece Inc., Salinas CA) were placed in transects of three to five traps around field perimeters. Traps were installed by burying the cage-catch can in the ground so that only the top assembly was visible. In Palmer during 2004 and 2005, JBT's were maintained from mid-May to late August on a truck crop farm producing various vegetable crops. During 2004, 19 traps were placed around onion (*Allium cepa* L.), potato, squash (*Cucurbita* spp.), and rhubarb (*Rheum* spp.) plantings during mid-May and maintained until late August. During 2005, nine traps were initially placed around pea (*Pisum sativum* L.), rhubarb, and onion plantings on 10 May; an additional six traps were then added to potato and squash on 29 June. Additionally during 2005, five JBT's were maintained around potato fields at one location in Fairbanks and two locations in Delta Junction. Traps were serviced weekly; beetles were removed, transported to the laboratory, placed in 80% ethanol for temporary storage, pinned, labeled, and identified.

Adhesive cards (yellow; 0.041m^2; Intercept®; IPM Tech, Portland, OR) were placed along potato field margins in the Tanana and Matanuska valleys during both years of the study. Yellow adhesive cards (henceforth referred to simply as "cards") were stapled flat to a wooden stake with the bottom of the trap at canopy height and placed around potato field perimeters at a density of eight cards per hectare. During 2004 cards (n = 21) were placed at three locations in Fairbanks, one location in Delta Junction and three locations in Palmer. During 2005 cards (n = 40) were placed at two locations in Fairbanks, two locations in Delta Junction, two locations in Nenana, and three locations in Palmer. Cards were placed around field perimeters just prior to potato emergence (mid to late June) and maintained until first frost/harvest (late August to early September) during 2004 and first snow-fall (mid- to late October) during 2005. Cards were changed weekly; used cards were placed in 3.8 L plastic bags (Ziploc®, SC Johnson Company, Racine, WI), taken to the laboratory, and held in a freezer. Most beetles were identified *in situ* on the cards; problematic species were removed, washed in xylene, and examined in 80% ethanol.

Water pan traps, as described by Irwin (1980) and Villanueva and Peña (1991), were placed along potato field margins in the Tanana and Matanuska valleys during both years of the study. During 2004, traps (n = 24) were placed at three locations in Fairbanks, one in Delta Junction and three in Palmer. During 2005, traps (n = 41) were placed at two locations in Fairbanks, two locations in Delta Junction, one location in

Nenana, and three locations in Palmer. Traps were placed around field perimeters just prior to potato emergence (mid to late June) and maintained until first frost/harvest (late August to early September) during 2004 and first snow-fall (mid- to late October) during 2005. Periodically during both years, additional pan traps were placed adjacent to small plantings of mixed vegetables and rhubarb at both Fairbanks and Palmer locations. Pan traps were changed bi-weekly and brought back to the laboratory where insects were strained from the soap solution and preserved in 80% ethanol.

Coccinellids were collected by hand picking when encountered at field sights to determine plant associations. Sweep net samples of 100 sweeps (four reps of 25 sweeps) were taken along potato field margins on a semi-weekly basis from locations in Fairbanks, Delta Junction, Nenana, and Palmer during 2005. Sweep net samples were not taken directly from potato foliage due to grower concerns about crop damage and to avoid possible mechanical spread of plant pathogens. Coccinellids, when inadvertently caught, were also collected from bucket style noctuid moth traps (Landolt *et al.* 2007).

Additionally, the University of Alaska Museum Insect Collection (UAM 2009) was examined to provide baseline information on coccinellid species in Alaska. The UAM includes the Washburn Insect Collection, which was amassed by USDA entomologists J. C. Chamberlin, R. H. Washburn, and others during the 1940's and 1950's. This collection, formerly housed in Palmer, AK, is the only large general insect collection maintained in the state (Washburn 1972).

All coccinellids were identified using taxonomic keys of Gordon (1985) and Gordon and Vandenberg (1991). Two representative individuals from most taxa were sent to Robert Gordon (retired, Systematic Entomology Laboratory, USDA) for identification confirmation. Voucher specimens were deposited in the UAM.

RESULTS AND DISCUSSION

During the field study, 1318 individuals representing 14 taxa were collected in or adjacent to agricultural habitats. Examination of the UAM revealed 196 individuals representing 10 taxa (Table 1). The majority of specimens at UAM were collected from the University of Alaska Fairbanks Research Farm in Palmer; however, label data for most specimens was insufficient to provide any meaningful agricultural crop associations. The field collected specimens included representatives of all species in UAM with the exception of *Anisosticta borealis* Timberlake and *Coccinella hieroglyphica mannerheimi* Mulsant that were not collected from the field. The most abundant species in the field collection, *Hippodamia quinquesignata quinquesignata* (Kirby), *Coccinella transversoguttata richardsoni* Brown, and *Hippodamia tredecimpunctata tibialis* (Say) were also numerous in the UAM Collection. *Macronaemia episcopalis* (Kirby), *Hippodamia falcigera* Crotch, *H. parenthesis* (Say), *H. convergens* Guerin, and *Coccinella septempunctata* L. were collected during the field study but no representatives were found in the UAM. Although the coccinellid species *Ceratomegilla ulkei* Crotch, *Hippodamia expurgata* Casey, *H. arctica* (Schneider), *H. sinuata spuria* LeConte, *Coccinella californica* Mannerheim, *C. johnsoni* Casey, *C. fulgida* Watson, *C. monticola* Mulsant 1850 and *Mulsantina hudsonica* (Casey) are listed for Alaska either singly or in combination by Belicek (1976), Gordon (1985), and McNamara (1991), these species were neither collected nor examined during this study (Table 1). The presence of these species in the state is uncertain. However, it is possible that they were not collected during this study due to its relatively narrow geographic scope or that the species are not associated with habitats commonly found near areas of agricultural production.

A total of 489 individuals representing

Table 1.
Lady beetle (Coccinellidae: Coccinellini) species listed from Alaska, numbers examined from University of Alaska Insect Collection (UAM) and numbers collected from the field during 2004 and 2005.

Taxon	Listed[1]	UAM	Field
Adalia bipunctata (L.)	4	18	45
Anatis mali (Say)	2,3	4	39
Anisosticta bitriangularis (Say)	4	5	3
Anisosticta borealis Timberlake	4	9	0
Calvia quatuordecimguttata (L.)	4	18	46
Ceratomegilla ulkei Crotch	4[2]	0	0
Coccinella californica Mannerheim	3	0	0
C. fulgida Watson	4	0	0
C. hieroglyphica mannerheimi Mulsant	4	4	1
C. johnsoni Casey	2,3	0	0
C. monticola Mulsant	3	0	0
C. septempunctata L.	-	0	7
C. transversoguttata richardsoni Brown	4	35	231
C. trifasciata perplexa Mulsant	4	7	53
Hippodamia arctica (Schneider)	4	0	0
H. convergens Guerin	-	0	43
H. expurgata Casey	2	0	0
H. falcigera Crotch	3	0	3
H. parenthesis (Say)	2,3	0	16
H. quinquesignata quinquesignata (Kirby)	4	11	677
H. sinuata spuria LeConte	4	0	0
H. tredecimpunctata tibialis (Say)	4	85	152
Macronaemia episcopalis (Kirby)	1,3	0	2
Mulsantina hudsonica (Casey)	1,3	0	0

[1] Belicek 1976 = 1; Gordon 1985 = 2; McNamara 1991 = 3; All 3 authors = 4.
[2] Listed as *Hippodamia ulkei* (Crotch) in Belicek 1976.

six taxa were collected from Japanese beetle traps during 2004 and 2005 (Table 2). Of those, *H. t. tibialis*, *H. q. quinquesignata*, and *C. t. richardsoni* were the most commonly collected taxa, making up 12, 51, and 18% of the total number of individuals collected respectively. *Hippodamia parenthesis*, *Adalia bipunctata* (L.), and *Coccinella trifasciata perplexa* Mulsant were collected in low numbers.

A total of 420 individuals representing 10 taxa were collected from yellow adhesive cards. *H. t. tibialis*, *H. q. quinquesignata*, and *C. t. richardsoni* were the most commonly collected taxa, making up 17, 62, and 13% of the total number of individuals collected respectively. *Hippodamia falcigera*, *H. parenthesis*, *H. convergens*, *Calvia quatuordecimguttata* (L.), *A. bipunctata*, *C. t. perplexa*, and *C. septempunctata* were collected in low numbers. No coccinellids were captured with cards at the Nenana locations during 2005. Due to staggered planting dates and other agronomic factors, data from different regions and study years could not be combined.

Coccinellids were collected sporadically in low numbers from pan traps during

Table 2.
Combined numbers of individuals of each taxon collected by all methods at each locality in the field study during 2004 to 2005.

Taxon	Location[1]				Date Range, All Locations
	F	D	N	P	
Adalia bipunctata (L.)	34	0	0	11	1 May -11 July
Anatis mali (Say)	39	0	0	0	10 May - 26 May
Anisosticta bitriangularis (Say)	1	0	2	0	22 June - 3 Aug.
Calvia quatuordecimguttata (L.)	31	0	1	14	10 May - 22 July
C. hieroglyphica mannerheimi Mulsant	0	0	0	1	28 July
C. septempunctata L.	6	0	0	1	19 July - 09 Aug.
C. transversoguttata richardsoni Brown	71	41	11	108	9 May - 6 Sept.
Coccinella trifasciata perplexa Mulsant	41	3	0	9	10 May - 12 Aug.
H. convergens Guerin	40	0	0	3	16 June - 13 Sept.
H. falcigera Crotch	1	0	0	2	9 June - 6 Sept.
H. parenthesis (Say)	3	4	6	3	9 May - 13 Sept.
H. quinquesignata quinquesignata (Kirby)	127	70	6	474	16 May - 9 Aug.
H. tredecimpunctata tibialis (Say)	55	1	4	92	10 May - 9 Aug.
Macronaemia episcopalis (Kirby)	0	1	1	0	21 July - 27 July

[1] Locations: F, Fairbanks; D, Delta Junction; N, Nenana; P, Palmer.

2004-2005 (Table 2). A total of 121 individuals representing nine taxa were collected. *H. t. tibialis*, *H. q. quinquesignata*, *H. convergens*, and *C. t. richardsoni* were the most commonly collected taxa, making up 19, 30, 17, and 19% of the total number of individuals collected respectively. *H. falcigera*, *H. parenthesis*, *C. quatuordecimguttata*, *A. bipunctata*, and *C. t. perplexa* were collected in low numbers. Insufficient numbers were collected of any taxon from any location to determine seasonal abundance. However, some crop associations can be made. *H. t. tibialis* were collected from potato (n = 7), rhubarb (n = 8), broccoli (*Brassica* spp.) (n = 1), and lettuce (*Lactuca sativa* L.) (n = 7); *H. q. quinquesignata* were collected from potato (n = 25), rhubarb (n=7), broccoli (n = 1), lettuce (n = 2), and tomato (*Solanum lycopersicum* L.) (n = 1). *C. t. richardsoni* was trapped from potato (n = 12), rhubarb (n = 3), broccoli (n = 3), lettuce (n = 3), and mixed vegetables (n = 2). *H. convergens* was collected from potato (n = 1), tomato (n = 3), and pansies (*Viola* spp.) (n = 16).

A total of 107 individuals representing 11 taxa was collected by sweeping along potato field perimeters during 2005 (Table 2). *H. t. tibialis*, *H. parenthesis*, *H. q. quinquesignata*, *C. trifasciata perplexa*, and *C. transversoguttata richardsoni*, were the most commonly collected taxa, making up 15, 9, 14, 15, and 37% of the total number of individuals collected respectively. Additionally, *A. bitriangularis*, *M. episcopalis*, *H. falcigera*, *Anatis mali* (Say), *C. quatuordecimguttata*, and *A. bipunctata* were collected in low numbers from herbaceous vegetation along potato field margins.

A total of 166 individuals representing 11 taxa were collected from foliage by hand picking (Table 2). *H. t. tibialis* was collected from rhubarb and lettuce. *H. q. quin-*

quesignata was collected from a wide variety of plants including eggplant (*Solanum melongena* L.), lettuce, potato, and rhubarb. *H. convergens* was collected from banana peppers and potato. *C. t. richardsoni* was collected from potato and tomato. *C. t. perplexa* was collected from eggplant, and rhubarb. During early May large numbers of *C. quatuordecimguttata* (n = 32), *A. mali* (n = 36), *A. bipunctata* (n = 27), *C. t. perplexa* (n = 13) were collected from European bird cherry (*Prunus padus* L.) near agricultural areas.

Although not directly comparable due to differences in numbers of field sites and sampling days in each region, little difference was noted in the relative abundance or species composition between the Tanana and Matanuska valleys. This is unexpected because the Matanuska valley is well known for its relatively mild climate compared to that of the Tanana valley in the interior. The majority of lady beetles was collected from Fairbanks and Palmer reflecting the relatively heavy collecting compared to other areas. In Delta, only one field site was sampled during 2004 and two sites during 2005. Relatively few specimens were collected during 2005 from the two sites in Nenana.

Hippodamia convergens and *C. septempunctata* are documented in Alaska for the first time (Table 1). Distribution maps of Acorn (2007) indicate the presence of *C. septempunctata* in the state; however, the source of the record is unstated and probably based on speculation.

Hippodamia convergens is found throughout the USA and southern Canada (Gordon 1985). *H. convergens* was collected in small numbers during both years of the study (Table 1) in association with potato and mixed vegetables (Table 2). Since *H. convergens* is commonly available commercially and was collected near population centers (Fairbanks and Palmer), it is assumed that these specimens are a result of private biological control releases. It is unclear at this time whether *H. convergens* is established in Alaska.

Coccinella septempunctata is one of several species of coccinellids propagated and released throughout the west by the USDA Animal and Plant Health Inspection Service for control of Russian wheat aphid (*Diuraphis noxia* [Mordoviko]) (Gordon and Vandenberg 1991). This species had been implicated in declines in abundance of native coccinellid species (Wheeler and Hoebeke 1995, Elliot *et al.* 1996, Alyokhin and Sewell 2004). The presence of this species in the study area is most likely the result of a natural range extension or accidental release because it is not readily available commercially (Hoffmann and Frodsham 1993). The apparently recent occurrence of *C. septempunctata* in Alaska should provide a unique opportunity to study its impact on native coccinellids in the state.

During this study members of the subspecies *H. t. tibialis, H. q. quinquesignata*, and *C. t. richardsoni* were collected in highest numbers in association with agricultural crops. Of those species, *H. q. quinquesignata* was, by far, the most abundant, representing 51% of the total number of individuals collected during the field study. Due to their abundance in or around agricultural areas, *H. t. tibialis, H. q. quinquesignata*, and *C. t. richardsoni* show the most potential as naturally occurring biological control agents in Alaskan agricultural systems. However, their role in Alaskan agricultural systems is in need of further study. Additional research is needed to determine seasonal abundance, habitat preference, and biology of these species in the state.

C. septempunctata has been reported to be invasive in some areas, displacing native species; its future impact on Alaskan coccinellid diversity should be monitored. *H. convergens* is available commercially in the state and its ability to overwinter is unknown.

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